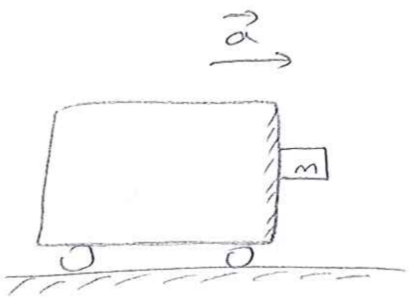
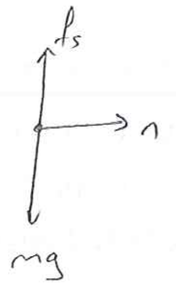
5.97)



Friction force will resist the gravitational force

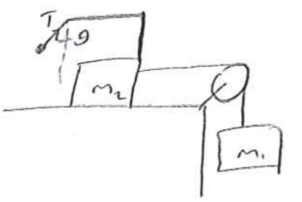


$n = ma$

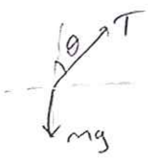
$mg = f_s = \mu_s n$

$\cancel{m}g = \mu_s \cancel{m}a \implies \boxed{a = \frac{g}{\mu_s}}$

5.100)



a) Tension in the rope accelerates the ball



$$\left.\begin{aligned} T\cos\theta &= mg \\ T\sin\theta &= ma \end{aligned}\right\} \quad \tan\theta = \frac{a}{g}$$

b) $m_1 g = (m_1 + m_2 + m_b)a$ $\quad m_b$ is too small so it is ignored.

$(250\,kg)g = (250\,kg + 1250\,kg)a \implies a = \frac{g}{6}$

$\tan\theta = \frac{1}{6} \implies \theta = \tan^{-1}\left(\frac{1}{6}\right) = 9.46°$

c) $m_1 g = (m_1 + m_2) a$

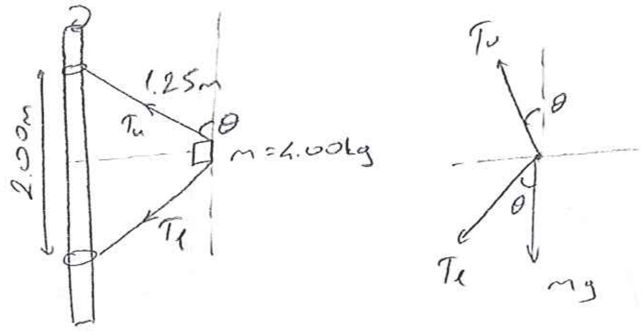
$$\frac{a}{g} = \frac{m_1}{m_1 + m_2}$$

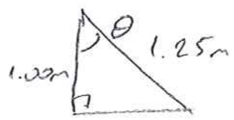
For large m_1, i.e, $m_1 \gg m_2$ $\quad \frac{m_1}{m_1+m_2} \cong 1$

$$\frac{a}{g} \cong 1 \Rightarrow \tan^{-1} 1 = 45°$$

θ cannot exceed $45°$.

5.110





$\cos\theta = \frac{4}{5}$

$\sin\theta = \frac{3}{5}$

a) $T_u \cos\theta = mg + T_l \cos\theta \Rightarrow T_l = T_u - \frac{mg}{\cos\theta}$

$$= 80.0N - \frac{(4.00kg)(9.80ms^{-2})}{\frac{4}{5}} = 31.0N$$

b) $T_l \sin\theta + T_l \cos\theta = m\frac{v^2}{r} \Rightarrow v = \sqrt{\frac{r(T_u + T_l)\sin\theta}{m}}$

$$= \sqrt{\frac{(0.75m)(80.0N + 31.0N) \cdot \frac{3}{5}}{4.00kg}} = 3.53 ms^{-1}$$

$$\frac{v}{2\pi r} = \underline{44.9 \text{ rev/min}}$$

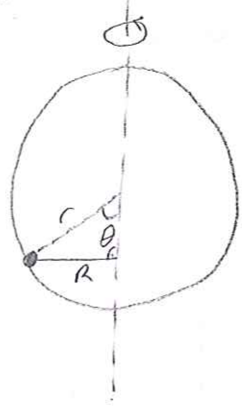
c) If lower cord go slack $T_l \to 0$

$$T_u \cos\theta = mg \Rightarrow T_u = \frac{mg}{\cos\theta} = 49.0\,N$$

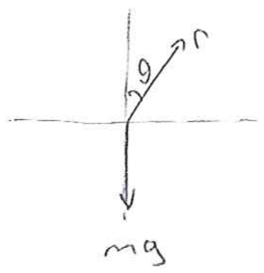
$$T_u \sin\theta = m\frac{v^2}{r} \Rightarrow v = \sqrt{\frac{r T_u \sin\theta}{m}} = 2.35\,ms^{-1}$$

$$\frac{v}{2\pi r} = 29.9 \text{ rev/min}$$

5.119



$R = r\sin\theta$



$$n\cos\theta = mg \Rightarrow n = \frac{mg}{\cos\theta}$$

$$n\sin\theta = m\frac{v^2}{r}$$

a) $$\frac{mg}{\cos\theta}\sin\theta = m\frac{v^2}{R} \Rightarrow gR\tan\theta = v^2 \qquad v = \frac{2\pi R}{T} \Rightarrow v^2 = \frac{4\pi^2R^2}{T^2}$$

$$gR\tan\theta = \frac{4\pi^2R^2}{T^2} \Rightarrow \tan\theta = \frac{4\pi^2 r\sin\theta}{gT^2} \Rightarrow \sec\theta = \frac{4\pi^2 r}{gT^2}$$

$$\cos\theta = \frac{gT^2}{4\pi^2 r}$$

b) $\theta = 90^\circ$

$$n = \frac{mg}{\cos\theta} = \frac{mg}{0} = \infty \Rightarrow$$ No, it is not possible.

c) We calculated that

$$\cos\theta = \frac{T^2 g}{4\pi^2 r} \quad \text{for } T = 1.00\,s \Rightarrow \cos\theta = 2.48 > 1.$$

This means the bead will stay at the bottom of the hoop.